**3GPP TSG RAN WG1 #101e R1-** **20xxxxx**

**May 25th – June 5th, 2020**

**Agenda item:** 7.2.5.4

**Source:** Moderator (Qualcomm)

**Title:** Summary of [101-e-NR-L1enh-URLLC-HARQ&Scheduling-02]

**Document for:** Discussion and Decision

# 1 Introduction

This document summarizes the companies’ views and captures the agreements related to the following email discussion:

**Email Discussion #2 by 5/29 and corresponding TP (if any) by 6/5 – Kianoush (Qualcomm):**

* *Cancellation timeline for the case that the high priority channel is transmitted without an associated scheduling PDCCH (e.g., CG-PUSCH, SR, etc.)*

**Companies are encouraged to share their initial feedback by 05/26.**

The summary of the companies’ proposals is available in [1].

# 2 Cancellation Handling with Configured High Priority Transmission

As part of this email discussion, RAN1 aims at determining the UE’s cancellation timeline and behaviour in case a high priority configured channel, i.e., SR or CG-PUSCH or PUCCH carrying only HARQ-ACK bits for SPS configuration(s), collides with low priority channels. **Note that CG-PUSCH+CG-PUSCH and CG-PUSCH+DG-PUSCH collision handling is not part of this discussion for now.**

Following the discussions during the RAN1 100e-b meeting, the feature lead recommendation is to start the discussions by considering the following proposals:

***Proposal 1: For handling collision between a high priority configured UL transmission and low priority channels in the following cases, it is up to UE implementation to ensure that the low priority UL transmission is cancelled no later than the start of the high priority UL transmission:***

* ***Case 1: Collision between a high priority SR PUCCH and any low priority channels***
* ***Case 2: Collision between a high priority CG-PUSCH and a low priority PUCCH***
* ***Case 3: Collision between a high priority PUCCH carrying only HARQ-ACK corresponding to PDSCH without corresponding PDCCH and any low priority configured uplink transmission.***

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| **Company** | **Agree/Disagree + Comment** |
| ZTE | Agree. |
| Nokia, NSB | We agree in principle that it should be left to UE implementation if earlier cancelation is done (not just the symbol before). Having said that, for cancelation of LP PUSCH (with MAC PDU delivered), if the UE could cancel even before the start of the transmission, the gNB will not know if the LP PUSCH had data mapped or not (i.e. skipping). It would be nice for the gNB to know if there had been data (i.e. a MAC PDU) for potential re-transmission decisions!  **Therefore, we agree with Case 2, but for Case 1 and Case 3, in case the low priority channel is PUSCH,** **we suggest the UE to not cancel the UL-DMRS transmission for LP PUSCH not overlapping with HP PUCCH.** That is: separation of Case 1 to Case 1a and Case 1b:   * Case 1a: Collision between a high priority SR and a low priority PUSCH, the UE will at least still transmit the first symbol containing DMRS (if not overlapping with HP SR).      * Case 1b: Collision between a high priority SR and a low priority channel other than PUSCH, it is up to UE implementation.   And similarly, separation of Case 3 to Case 3a and Case 3b:   * Case 3a: Collision between a high priority PUCCH carrying only HARQ-ACK corresponding to PDSCH without corresponding PDCCH and a low priority PUSCH, the UE will at least still transmit the first symbol containing DMRS (if not overlapping with HP PUCCH). * Case 3b: Collision between a high priority PUCCH carrying only HARQ-ACK corresponding to PDSCH without corresponding PDCCH and a low priority channel other than PUSCH, it is up to UE implementation. |
| Ericsson | We are in principle OK with the proposal.  Additionally, our understanding is that the proposal is about collision resolution on physical layer. It means that a transmission would occur if there would have been no collision (in other words it means that CG-PUSCH includes TB, SR includes positive SR, and PUCCH for CSI includes CSI report, and PUCCH for DL SPS includes HARQ).  If the above understanding is not the underlying assumption, we need to further discuss.  If the above understanding is the underlying assumption, we apply the same logic as we described for Proposal 2 to motivate the proposal. |
| Qualcomm | Agree with the proposal.  In response to question from Ericsson, in our understanding, the following is the assumption “a transmission would occur if there would have been no collision.” |
| DOCOMO | Agree with the proposal. |
| Samsung | Agree with the proposal |
| Intel | Agree with the proposal |
| vivo | Agree.  For case 2: one FFS can be added in sub-bullet for the case of collision between a high priority CG-PUSCH and a low priority PUSCH. Since wheter/how to support CG-PUSCH+CG-PUSCH and CG-PUSCH+DG-PUSCH collision is being discussed in another part, cancellation timeline seems to be resuable if this case is supported. So, we can further discuss the timeline for this case if needed. |
| Apple | Agree with the proposal |
| Spreadtrum | Agree with the proposal in principle.  One additional comments for SP-CSI PUSCH can be included in the proposal. From our understanding, it can be in Case 1 or Case 3 or a new Case. Because SP-CSI PUSCH is without UL-SCH and can be configured as HP as agreed in RAN1 #98bis.  Agreements:  For handling intra-UE collision in R16,   * P/SP-CSI on PUCCH is treated with low priority. * The priority of a SP-CSI on PUSCH depends on the 2-level PHY priority of the PUSCH conveying the SP-CSI. * The priority of a A-CSI depends on the 2-level PHY priority of the PUSCH (w/ or w/o UL-SCH) conveying the A-CSI. |
| HW/HiSi | Agree with the proposal in principle. One question: in order to capture the case that the HP is starting before the LP, should the main bullet be revised to? The following would maybe clearer than the original proposal?  ***Proposal 1: For handling collision between a high priority configured UL transmission and low priority channels in the following cases, it is up to UE implementation to ensure that the low priority UL transmission is cancelled from the first symbol that is overlapping with the ~~no later than the start of the~~ high priority UL transmission:*** |
| OPPO | Agree with the proposal |
| Sony | Agree with the proposal |
| CATT | We agree with the proposal in principle. Given that there are overlapping PUSCH cases under discussion in eCG AI, we would prefer to add ”at least” at the beginning of the proposal (highlighted in yellow) and to see whether it applies to LP PUSCH+HP CG case(s) as well if we agree to support the case(s).  ***Proposal 1: At least for handling collision between a high priority configured UL transmission and low priority channels in the following cases, it is up to UE implementation to ensure that the low priority UL transmission is cancelled no later than the start of the high priority UL transmission:***   * ***Case 1: Collision between a high priority SR PUCCH and any low priority channels*** * ***Case 2: Collision between a high priority CG-PUSCH and a low priority PUCCH*** * ***Case 3: Collision between a high priority PUCCH carrying only HARQ-ACK corresponding to PDSCH without corresponding PDCCH and any low priority configured uplink transmission.*** |
| NEC | Agree with the proposal. |

***Proposal 2: For handling collision between a high priority PUCCH carrying only HARQ-ACK corresponding to PDSCH without corresponding PDCCH and anydynamically scheduled low priority uplink transmission, adopt one of the following two options:***

* ***Option 1: It is up to UE implementation to ensure that the low priority UL transmission is cancelled no later than the start of the high priority UL transmission***
* ***Option 2: A UE is not expected to be scheduled with a PUCCH or PUSCH with low priority overlapping with a high priority PUCCH carrying only HARQ-ACK for PDSCH without corresponding PDCCH.***

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| **Company** | **Option 1 or 2 + Reason for your choice** |
| ZTE | We support Option 1. We needn’t split this issue from case 3 in proposal 1. |
| Nokia, NSB | Option 1, but the same different handling as for Proposal 1 suggested above – i.e. if the canceled LP channel is PUSCH or not (for PUSCH, the UE should at least still transmit the first symbol containing DMRS if not overlapping) |
| Ericsson | We support Option 1.  First, we need to clarify an underlying assumption as we describe in the following:  When a DL-SPS is activated, if the UE does not detect a DL-SPS PDSCH in one of the configured resources for DL-SPS, i.e. the UE does not receive a DL SPS,   * Alt 1) does the UE feedback NACK on PUCCH? * Alt 2) does the UE skip HARQ (i.e. no PUCCH transmission)?   //====38.213, Clause 9.2.3=====  For a SPS PDSCH reception ending in slot , the UE transmits the PUCCH in slot  where  is provided by the PDSCH-to-HARQ\_feedback timing indicator field, if present, in a DCI format activating the SPS PDSCH reception.  //==========================   * If Alt1 is the underlying assumption, Option 1 is a better approach. For that, we are hoping the UE operates in a reasonable way and if doesn’t detect any DL PDSCH transmission, transmits the low priority, and if it detects DL SPS PDSCH, it would transmit PUCCH carrying HARQ. Again, that is a reasonable UE implementation. * If Alt 2 is the underlying assumption, Option 1 is still a better approach. Since it implies that the HARQ in PUCCH corresponds to actual reception of PDSCH. Hence, the gNB knows low priority would be dropped any way and can avoid scheduling colliding low priority colliding with DL SPS PUCCH. But if the gNB does not transmit DL SPS, can utilize PUCCH resources for scheduling uplink. |
| Qualcomm | Option 2. The reason is that even if the UE does not decode any SPS PDSCH, regardless of whether the gNB had sent data or not, the UE will transmit HARQ-ACK on PUCCH. Hence, the reasonable implementation pointed out by Ericsson is not even feasible since the UE cannot tell the difference between the case PDSCH failed decoding and the case when PDSCH was not sent.  With this behavior, any low priority uplink transmission colliding with a high priority PUCCH for SPS will be cancelled. It would be great if the proponents of Option 1 can explain then why such a scheduling decision is even reasonable. |
| DOCOMO | We support the option 1. Same handling as the case for proposal 1 should be sufficient. |
| Samsung | Option 1 is preferable. We understand the motivation of option 2 as mentioned by Qualcomm. But, option 2 seems quite limited implementation to gNB since it is likely that gNB schedules overlapping “a high priority PUCCH carrying only HARQ-ACK for PDSCH without corresponding PDCCH” and “another high priority PUSCH”, and the “another high priority PUSCH” is not overlapped with “a PUCCH or PUSCH with low priority” as following figure. That is, gNB cannot schedule LP PUCCH or PUSCH even if HP HARQ-ACK for DL SPS would be piggybacked into HP PUSCH. |
| Intel | Both options could work, but Option 2 seems sufficient.  For the use case mentioned by Samsung, if the UE receives the UL grant for the HP PUSCH before the PDCCH with the DCI scheduling the LP PUCCH/PUSCH, then the SPS HARQ-ACK could indeed be multiplexed in the HP PUSCH, and in this case, Option 2 may not even apply since it says “***A UE is not expected to be scheduled with a PUCCH or PUSCH with low priority overlapping with a high priority PUCCH carrying only HARQ-ACK for PDSCH without corresponding PDCCH***”.  It would be good to hear thoughts from others on the above interpretation. |
| vivo | Option 2 is preferred. We share the same with view Qualcomm, it does not make sense that gNB schedules one UL transmission that is going to be cancelled. |
| Apple | Option 2 is preferred. As commented by Qualcomm and vivo, reasonable network implementation should not bring UE to such impossible situation. |
| Spreadtrum | We support Option 2. Although Option 1 seems can work but gNB will not schedule a LP UL transmission and know it is going to be canceled. It does not make sense.  For the example from Samsung, we think it can be handled by the multiplexing order of different UL priorities, same priority first and then different priority second. If this HP PUCCH for SPS PDSCH is going to be multiplexed to a HP PUSCH, the UE does not need to resolve the collision between HP PUCCH for SPS PDSCH and a dynamically scheduled LP PUSCH. |
| HW/HiSI | We support Option 2. There seems no use case for the gNB to schedule the DG with low priority overlapping with a HP PUCCH carrying ACK. |
| OPPO | We support the option 1. Unified solution is applied for all cases in proposal 1 and 2. |
| Sony | Option 2. The PUCCH carrying HARQ-ACK for SPS PDSCH is known to the gNB BEFORE it schedules any dynamic PUSCH. So it doesn’t make sense for gNB to deliberately schedule a LP PUSCH and then cancels it. |
| Samsung | As per recommendation from FL, if a grant scheduling second HP PUSCH is transmitted earlier than a grant scheduling LP PUCCH/PUSCH, we agree that there is no overlapping between LP PUCCH/PUSCH and HP PUCCH for DL SPS, which is not case explained in the proposal. Otherwise, it may be possible if two grants (one is for LP PUCCH/PUSCH, the other is for HP PUSCH) are scheduled the same time. Having said that, we acknowledge that this is rare case. One suggestion is that this issue should be revisited after we conclude issue#3 (multiplexing vs. prioritization order) in email thread#1. For example, if it goes option 3 to determine multiplexing/prioritization timeline, it seems to naturally solve the issue with selecting option 2 since UE will determine prioritization right after two different priority channels are overlapped. |
| CATT | We think a reasonable gNB scheduling should not schedule a LP channel to be overlapped with a HP channel which is expected to be transmitted. |
| NEC | We support option 2. Given that gNB knows UE will send the HP UL transmission, there is no reason that gNB will still schedule a LH UL transmission overlapped with the HP UL transmission. |

### 2.1 Summary of the Discussions and Next Steps for Proposal 1

Regarding proposal 1, the companies’ positions are as follows:

**Supporting companies:** ZTE, Ericsson, Qualcomm, DOCOMO, Samsung, Intel, vivo, Apple, OPPO, Spreadtrum, HW/HiSi, Sony, CATT , NEC (~~13~~ 14)

Nokia is proposing to update the proposal such that the UE transmits DMRS associated with the low priority channel in some subset of scenarios.

* **Feature lead comment: This behavior complicates the UE implementation as it enforces the UE to continue the transmission up to a certain point. Also, DMRS transmission is not possible if the DMRS symbol overlaps with the high priority channel (as also pointed out by Nokia.)**

vivo is proposing to add an FFS for the case of collision between a high priority CG and a low priority PUSCH.

* **Feature lead comment: Such cases can be discussed later if there is any agreement in other AIs.**

Spreadtrum is proposing to also include SP-CSI in the proposal.

* **Feature lead comment: All low priority channels including PUSCH carrying SP-CSI are covered by the current proposal.**

HW/HiSi is proposing some changes to cover the cases where the transmission of the high priority channel starts before the start of the low priority channel.

* **Feature lead comment: The proposed wording with the addition of “at the latest” is included in the updated proposals.**

Based on the comments, the proposal is updated as follows:

***Proposal 1: At least for handling collision between a high priority configured UL transmission and low priority channels in the following cases, it is up to UE implementation to ensure that the low priority UL transmission is cancelled, at the latest, from the first symbol that is overlapping with the high priority UL transmission:***

* ***Case 1: Collision between a high priority SR PUCCH and any low priority channels***
* ***Case 2: Collision between a high priority CG-PUSCH and a low priority PUCCH***
* ***Case 3: Collision between a high priority PUCCH carrying only HARQ-ACK corresponding to PDSCH without corresponding PDCCH and any low priority configured uplink transmission.***
* ***Case 4: Collision between a high priority PUSCH carrying SP-CSI and a low priority PUCCH***

If the updated Proposal 1 above is not agreeable, please fill in the following table:

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| **Company** | **Reasons/concerns** |
| CATT | Propose to add “at least” at the beginning of the proposal. |

### 2.2 Summary of the Discussions and Next Steps for Proposal 2

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| Companies supporting Option 1 | ZTE, Nokia/NSB, Ericsson, DOCOMO, ~~Samsung~~, OPPO (~~6~~5) |
| Companies supporting Option 2 | Qualcomm, Intel, vivo, Apple, Spreadtrum, HW/HiSi, Sony, Samsung, CATT, NEC (~~9~~ 10) |

**Feature lead comment: Regarding the case illustrated in the response from Samsung, as also mentioned in Intel’s response, indeed if the second high-priority grant is received before the low priority grant, there is no issue at all. If the second high- priority grant, however, is received after the low priority grant, since the operation is left to the UE, almost certainly, the UE cancels the low priority transmission, and will not wait for any other grant.**

### 2.3 Agreements

RAN1 made the following agreements:

**Agreement:**

*At least for handling collision between a high priority configured UL transmission and low priority channels in the following cases, it is up to UE implementation to ensure that the low priority UL transmission is cancelled, at the latest, from the first symbol that is overlapping with the high priority UL transmission:*

* *Case 1: Collision between a high priority SR PUCCH and any low priority channels*
* *Case 2: Collision between a high priority CG-PUSCH and a low priority PUCCH*
* *Case 3: Collision between a high priority PUCCH carrying only HARQ-ACK corresponding to PDSCH without corresponding PDCCH and any low priority configured uplink transmission.*
* *Case 4: Collision between a high priority PUSCH carrying SP-CSI, except the first PUSCH after the activation DCI, and a low priority PUCCH*

**Agreement:**

* *A UE is not expected to be dynamically scheduled with a PUCCH or PUSCH with a lower priority overlapping with a higher priority PUCCH carrying only HARQ-ACK for PDSCH without corresponding PDCCH.*
* *A UE is not expected to be dynamically scheduled with a PUCCH with a lower priority overlapping with a higher priority PUSCH carrying SP-CSI excluding the first PUSCH activated by a DCI.*

# 3 Proposed Text Proposal

Based on the agreements captured in the preceding section, the following TPs are proposed for agreement:

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| **Modified Clause (Section 9 of TS 38.213)**  A PUSCH or a PUCCH, including repetitions if any, can be of priority index 0 or of priority index 1. If a priority index is not provided for a PUSCH or a PUCCH, the priority index is 0. If in an active DL BWP a UE monitors PDCCH either for detection of DCI format 0\_1 and DCI format 1\_1 or for detection of DCI format 0\_2 and DCI format 1\_2, a priority index can be provided by a priority indicator field. If a UE indicates a capability to monitor, in an active DL BWP, PDCCH for detection of DCI format 0\_1 and DCI format 1\_1 and for detection of DCI format 0\_2 and DCI format 1\_2, a DCI format 0\_1 or a DCI format 0\_2 can schedule a PUSCH transmission of any priority and a DCI format 1\_1 or a DCI format 1\_2 can schedule a PDSCH reception and trigger a PUCCH transmission with corresponding HARQ-ACK information of any priority. If, after resolving overlapping for PUCCH and/or PUSCH transmissions of a same priority index, a UE determines to transmit  - a first PUCCH of larger priority index, a PUSCH or a second PUCCH of smaller priority index, and a transmission of the first PUCCH would overlap in time with a transmission of the PUSCH or the second PUCCH, the UE does not transmit the PUSCH or the second PUCCH  - a PUSCH of larger priority index, a PUCCH of smaller priority index, and a transmission of the PUSCH would overlap in time with a transmission of the PUCCH, the UE does not transmit the PUCCH  - a first PUSCH of larger priority index on a serving cell, a second PUSCH of smaller priority index on the serving cell, and a transmission of the first PUSCH would overlap in time with a transmission of the second PUSCH, the UE does not transmit the second PUSCH, where at least one of the two PUSCH is not scheduled by a DCI format  **If a UE would transmit a first PUCCH of a larger priority index carrying SR overlapping with a second PUCCH or PUSCH of a smaller priority index, or would transmit a PUSCH corresponding to a configured grant of a larger priority index overlapping with a PUCCH of a smaller priority index, or would transmit a first PUCCH of a larger priority index to report HARQ-ACK information in response to PDSCH without a corresponding PDCCH overlapping with a second PUCCH of a smaller priority index carrying SR or with a PUSCH corresponding to a configured grant with a smaller priority index, or would transmit a PUSCH of a larger priority index activated by a PDCCH with CRC scrambled by SP-CSI-RNTI, except the first PUSCH, overlapping with a PUCCH of a smaller priority index, the UE is expected to cancel the transmission of a PUCCH/PUSCH of a smaller priority index from the first symbol overlapping with a transmission of a PUCCH/PUSCH of a larger priority index at the latest.**  **A UE does not expect to be scheduled to transmit a first PUCCH or a PUSCH with a smaller priority index overlapping with a second PUCCH of a larger priority index to report HARQ-ACK information in response to PDSCH without a corresponding PDCCH. A UE does not expect to be scheduled to transmit a PUCCH of a smaller priority index overlapping with a PUSCH of a larger priority index activated by a PDCCH with CRC scrambled by SP-CSI-RNTI except the first PUSCH.** |

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| **Company** | **Reasons/concerns** |
| Nokia, NSB | We support the TP, maybe a minor editorial suggestion to make the first paragraph more readable – use some subbullets for the cases, i.e (magenta – Kianoush/FL, red – Klaus edits).  **If a UE would transmit**  **- a first PUCCH of a larger priority index carrying SR overlapping with a second PUCCH or PUSCH of a smaller priority index, or**  **- ~~would transmit~~ a PUSCH corresponding to a configured grant of a larger priority index overlapping with a PUCCH of a smaller priority index, or**  **- ~~would transmit~~ a first PUCCH of a larger priority index to report HARQ-ACK information in response to PDSCH without a corresponding PDCCH overlapping with a second PUCCH of a smaller priority index carrying SR or with a PUSCH corresponding to a configured grant with a smaller priority index, or**  **- ~~would transmit~~ a PUSCH of a larger priority index activated by a PDCCH with CRC scrambled by SP-CSI-RNTI, except the first PUSCH, overlapping with a PUCCH of a smaller priority index,**  **the UE is expected to cancel the transmission of a PUCCH/PUSCH of a smaller priority index from the first symbol overlapping with a transmission of a PUCCH/PUSCH of a larger priority index at the latest.** |
| Apple | **We start with Nokia’s version, suggest to add “carrying SR” to handle potential conflict**  **Case 4 and " A UE is not expected to be dynamically scheduled with a PUCCH with a lower priority overlapping with a higher priority PUSCH carrying SP-CSI excluding the first PUSCH activated by a DCI.”**  **-----------**  **If a UE would transmit**  **- a first PUCCH of a larger priority index carrying SR overlapping with a second PUCCH or PUSCH of a smaller priority index, or**  **- ~~would transmit~~ a PUSCH corresponding to a configured grant of a larger priority index overlapping with a PUCCH of a smaller priority index, or**  **- ~~would transmit~~ a first PUCCH of a larger priority index to report HARQ-ACK information in response to PDSCH without a corresponding PDCCH overlapping with a second PUCCH of a smaller priority index carrying SR or with a PUSCH corresponding to a configured grant with a smaller priority index, or**  **- ~~would transmit~~ a PUSCH of a larger priority index activated by a PDCCH with CRC scrambled by SP-CSI-RNTI, except the first PUSCH, overlapping with a PUCCH of a smaller priority index carrying SR,**  **the UE is expected to cancel the transmission of a PUCCH/PUSCH of a smaller priority index from the first symbol overlapping with a transmission of a PUCCH/PUSCH of a larger priority index at the latest.** |

# 4 References

**[1] R1-2004674, “Summary#1 on UCI enhancements for R16 URLLC,” Moderator (OPPO)**